

# EPIC Simulation of Landscape and Management Effects on Soil Organic Carbon Dynamics

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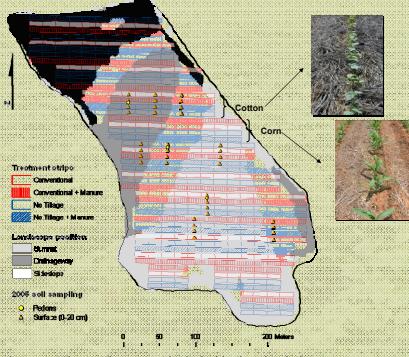
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Simulation models integrate our understanding of soil organic C (SOC) dynamics and are useful tools for evaluating impacts of crop management on soil C sequestration; yet, they require local calibration. We calibrated the Environmental Policy Integrated Climate (EPIC) model against results from a site-specific experiment in central Alabama, using an automatic parameter optimization procedure. We then evaluated the model performance in predicting corn and cotton yields and SOC fractions on different Coastal Plain soil landscapes (Typic, Oxyaeric and Aquic Paleudults) during the 5 initial years of conservation tillage adoption.

## Experiment layout and soil sampling locations



## Hypothesis

EPIC is capable of simulating crop yields and SOC as a function of soil landscape and short-term management

## Methods



### Model Calibration Procedure

- Calibration on conventional tillage summit position
- Selection of parameters based on literature and expert knowledge
- Generated 1500 sets for yield parameters using SimLab
- 1500 EPIC runs with yield parameter sets using i-EPIC
- Sensitivity analysis to determine the most influential yield parameters
- Uncertainty analysis to calculate likelihood weights using GLUEWin
- Aggregated function to determine the calibrated parameter set

$$F_{\text{yields}} = \sqrt{\frac{1}{2} L(\theta_i | \bar{Y}_{\text{cot ton}})^2 + \frac{1}{2} L(\theta_i | \bar{Y}_{\text{corn}})^2}$$

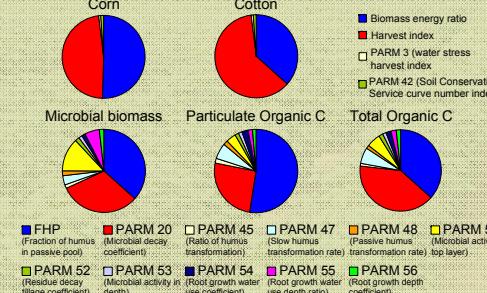
- Similar to steps 3-7 for SOC parameters

### Model Validation

Conventional tillage and no-tillage with or without manure application at three landscapes (summit, sideslope, drainageway)

## Results

### Total order sensitivity indices for Crops and SOC fractions

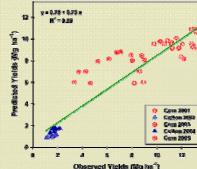


Pie graphs show how variation in EPIC outputs was apportioned to parameter variations. Parameters producing most of the variation were identified for subsequent optimization.

## Sensitive parameters and calibrated values

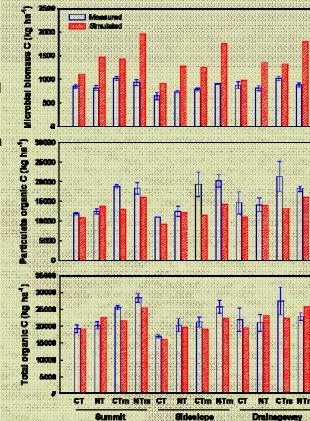
Parameter	Calibrated value
Corn	
Biomass energy ratio (kg ha <sup>-1</sup> MJ <sup>-1</sup> )	32.42
Harvest index	0.50
Cotton	
Biomass energy ratio (kg ha <sup>-1</sup> MJ <sup>-1</sup> )	13.00
Harvest index	0.54
Soil organic carbon	
FHP (fraction of humus in passive pool)	0.41
PARM 20 (microbial decay coefficient)	0.57
PARM 51 (microbial activity in top layer)	0.40

## Simulated and measured average crop yields



A regression relating simulated to measured values had a slope and intercept which were significantly different from 1 and 0, respectively. Overall, 48% of the simulated yields were within 20% of measured yields.

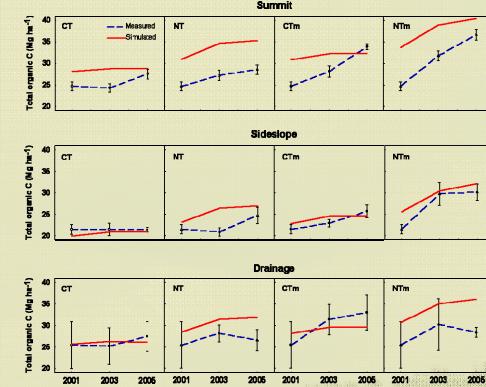
## Measured and simulated SOC fractions (0-20 cm) affected by landscape position and treatment in 2005



The best agreement between measured and simulated SOC fractions was obtained for total organic C.

A possible explanation for the disagreement between measured and simulated microbial biomass and particulate organic C may be that the analytical procedure used was not necessarily the fraction simulated by EPIC. Definition of a protocol for analyzing these fractions is necessary.

## Measured and simulated total organic C affected by landscape and treatments (0-30 cm) in 2001, 2003 and 2005



CT = conventional tillage; NT = no tillage; CTm = conventional tillage + manure; NTm = no tillage + manure

Dairy manure additions and conservation tillage practices increased total organic C but measured C stocks at the 0-30 cm depth of these degraded soils are still low. EPIC tended to overestimate total organic C, but mimicked variations with time.

## Summary and Conclusions

- Automated parameter optimization procedures can be applied to EPIC.
- Simulated crop yields were lower than measured crop yields in most years.
- EPIC adequately explained the variability of total organic C (0-30 cm) as affected by management after a 5-yr simulation. However, agreement between measured and simulated microbial biomass C and particulate organic C was poor.
- Adjustment of other model parameters and more research to define methods for analytical determination are needed.
- Overall, EPIC was sensitive to spatial differences that resulted from differing soil landscapes.
- EPIC modeling has challenges to overcome, but could be a reasonably accurate tool to predict yield and SOC dynamics for the >10 million acres of corn and cotton land in the southeastern USA.